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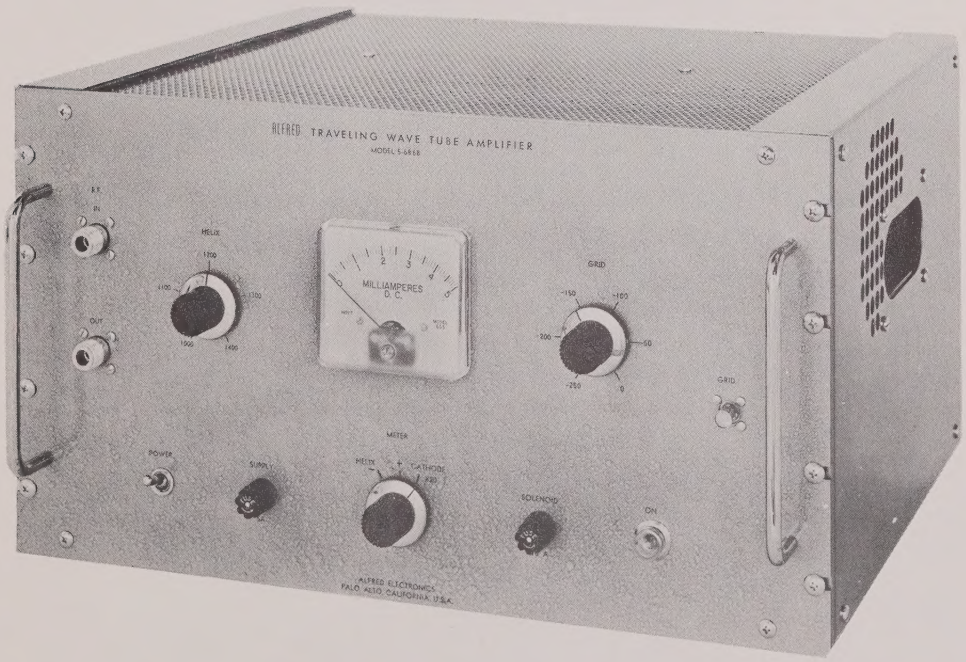
ALFRED ELECTRONICS 3176 PORTER DRIVE. PALO ALTO. CALIF.

MICROWAVE AMPLIFIER
MODEL 5-6868

Serial No. 97



ALFRED ELECTRONICS 3176 PORTER DRIVE, PALO ALTO, CALIF.

ADDENDUM SHEET

Model 5-6868

Date	Change No.	Effective S/N	Description
-19-63	12152	118 & up	Paragraph 2-4: Last sentence of fourth paragraph delete, "to give panel HELIX control calibration within 2%." Paragraph 3-2: To line 8, add this note. "This voltage can be monitored at TP-1 and TP-2". Paragraph 4-2: Line 5 Replace "...indications are within 2% for any setting." with "... range covered is within the limits of 980 to 1428 volts."

MICROWAVE AMPLIFIER
MODEL 5-6868

SPECIFICATIONS

Frequency Range:	2.0 to 4.0 Gc
Saturated Power Output:	10 watts minimum, into 50 ohm load
Gain (small signal):	33 db minimum
(at max. power output):	20 db minimum
Gain Adjustment:	0 to 30 db minimum gain and power level reduction by adjustment of panel GRID control from 0 to -250 volts.
Noise Figure:	40 db maximum
Spurious Modulation:	At least 35 db below output signal level.
RF Impedance:	50 ohms
RF Connectors:	Type N female
VSWR (Input and Output):	3:1 maximum
External Modulation (Grid)	
Connection:	Panel BNC receptacle capacitively coupled to TW tube grid. External signal adds to internal DC bias. Diode clamps signal positive peak to cathode potential.
Control Characteristic:	Gain and power output decrease proportionally to negative grid voltage at about .11 db/volt.
Response:	10 cps to above 10 mc/s
Input Impedance:	500 K, shunted by approximately 55 mmfd.
Metering:	Helix or cathode current on 3" front panel meter, selected by front panel switch. Helix voltage available at rear for checking with external precision voltmeter.
Front Panel Controls:	GRID voltage (0 to -250 volts) HELIX voltage (1100 to 1400 volts) METER current switch
Power Supply:	All electrode voltages are regulated except TW tube heater and solenoid. Protective relay shuts off TW tube electrode voltages upon helix overcurrent.
Input Voltage:	105 to 125 volts, 60 cps, approximately 960 VA.
Physical:	Bench mounting with perforated metal dust covers. Sides with recessed handles may be removed to permit rack installation. Height: $10\frac{1}{2}$" Width: 19" Depth: 15" from panel, $16\frac{1}{2}$" overall
Finish:	Panel, gray hammertone Sides, top and bottom, dark metallic gray
Weight:	80 pounds

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SECTION 1 - GENERAL

1-1 DESCRIPTION

The ALFRED Model 5-6868 Microwave Amplifier is a stable, wide band, high gain power amplifier and modulator of microwave signals in the frequency range of 2 to 4 Gc. It consists of a traveling wave tube, its focusing solenoid, and a power supply arranged in a compact and versatile unit. Thus the varied and unique traveling wave tube characteristics may be conveniently applied to laboratory and systems use. Some possible applications are:

1. Power amplification of wide band signal generator outputs or complex modulated RF signals, including RF pulses with rise times as short as a few millimicroseconds.

2. RF modulation by application of pulses or other AC signals to TW tube grid.

3. Isolation of a load from a microwave signal source.

4. Generation of extremely stable microwave oscillations either at fixed frequency or tunable over a wide range, using an external resonant feedback network.

On the front panel of the Model 5-6868, type N fittings are provided for RF input and output. A BNC receptacle permits AC coupled connection to the TW tube grid. Controls for grid and helix voltages are provided to optimize performance for specific applications. A panel meter may be selected by a switch to monitor either TW tube Helix or Cathode current.

The TW tube requires no RF adjustment, is encapsulated for protection, and is easily replaced.

The Model 5-6868 is built as a convenient laboratory bench instrument. However, simply by removal of outside sheet metal sides, it may be mounted in a standard relay rack.

SECTION 2 - THEORY OF OPERATION

2-1 GENERAL DESCRIPTION OF TW TUBE

The physical arrangement of the traveling wave tube is indicated in Figure No. 1. The electron gun produces a beam of electrons which travel down the axis of the helical wire coil to the collector. The magnetic flux from the surrounding solenoid restricts the beam to travel axially along the tube just inside the helix. RF signals at low impedance are coupled to the helix at the electron gun end, and travel down the metallic path of the helix. The velocity of the electron beam is critically adjusted by the potential difference of the cathode and helix so that the beam velocity down

the axis is just a little faster than the progressive RF signal of the helix. The field of the helix RF signal causes the electrons to bunch, so that at the collector end, their increased field returns to the helix an amplified signal which is coupled out through a low impedance connection. Reflections down the helix are prevented by the attenuator, consisting of lossy material positioned between RF input and output. The low impedance connections to the helix and the relatively long effective path for interaction with the beam make possible uniform amplification over a broad band of frequencies. To simplify the tube and its power supply, the last anode in the electron gun is internally connected to the helix.

Amplitude modulation is accomplished in the gun by varying the beam density in accordance with a voltage applied to a control grid. A more complete description and associated pertinent information are presented in the Engineering Notes at the end of this Manual.

2-2 TW TUBE PERFORMANCE CHARACTERISTICS

Gain and Power Output vs. Frequency

Figure No. 2 shows typical curves of small signal gain, gain at maximum output, and maximum power output as a function of frequency. These curves are taken with helix voltage fixed at rated broadband value. The small signal gain is better than 30 db over the frequency range of 2 to 4 Gc. Gain at maximum output is greater than 20 db over the same frequency band.

Power Output vs. Power Input

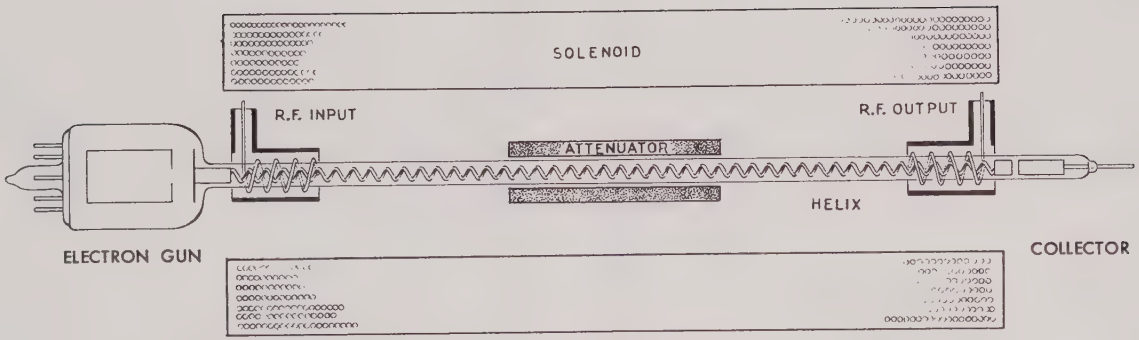
Figure No. 3 shows power output vs. power input performance at 3 frequencies. The curves exhibit the typical traveling wave tube characteristic in that power output is a linear function of power input, until the output level is about 6 db below maximum value. Beyond this the curve becomes non-linear, levels off, and then decreases as greater RF input is applied.

Grid Characteristics

Figure No. 4 shows curves of relative power output and gain vs. grid voltage at mid-band for several values of grid voltage. The grid is a low current electrode operated negatively with respect to TW tube cathode. It controls beam current, gain and power output of the TW tube. Varying grid voltage with an external signal applied to the panel GRID connector can achieve fast response amplitude modulation of beam and RF output.

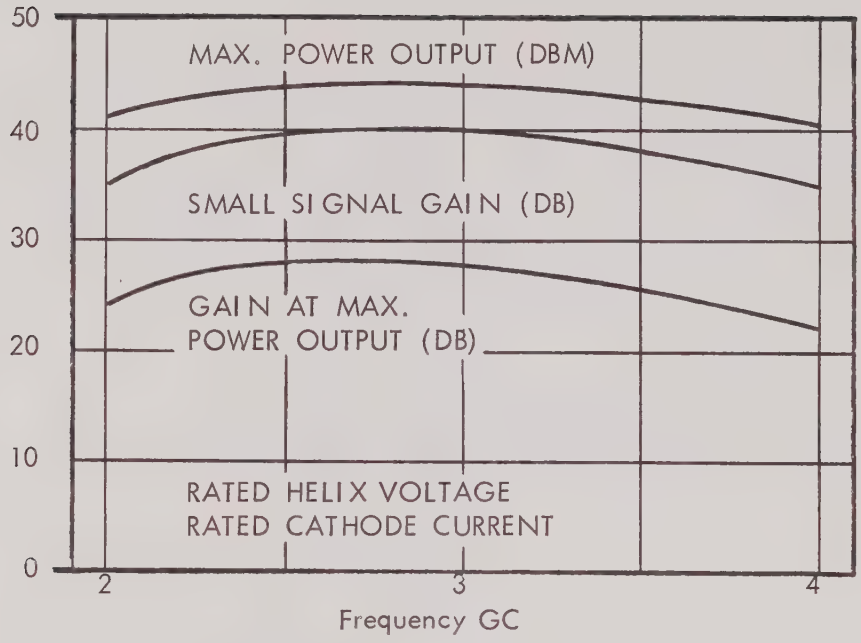
2-3 RF LOAD

The TW tube may be operated at any cathode current up to rated value, into a RF load with a maximum VSWR of 3:1. Performance will be stable without spurious oscillations, but output power will be less into mismatched loads.

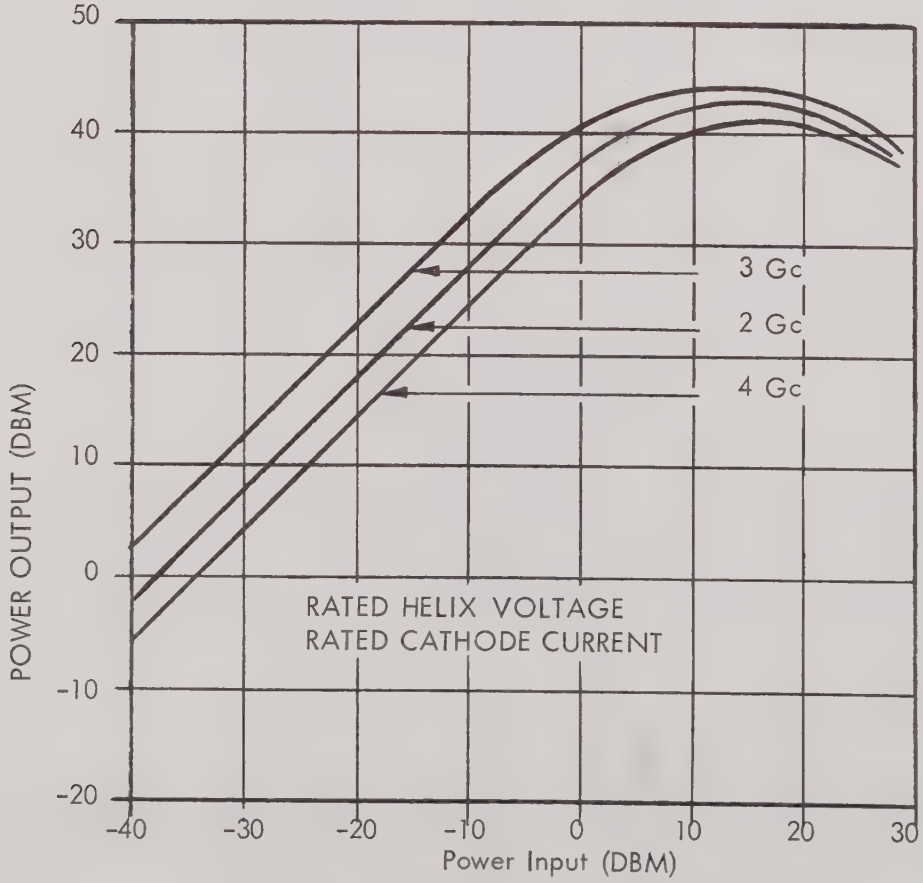


Schematic View of Traveling-Wave Tube

FIGURE 1



POWER OUTPUT AND GAIN VS. FREQUENCY
Figure 2



POWER OUTPUT VS. POWER INPUT
Figure 3

GRID CHARACTERISTICS

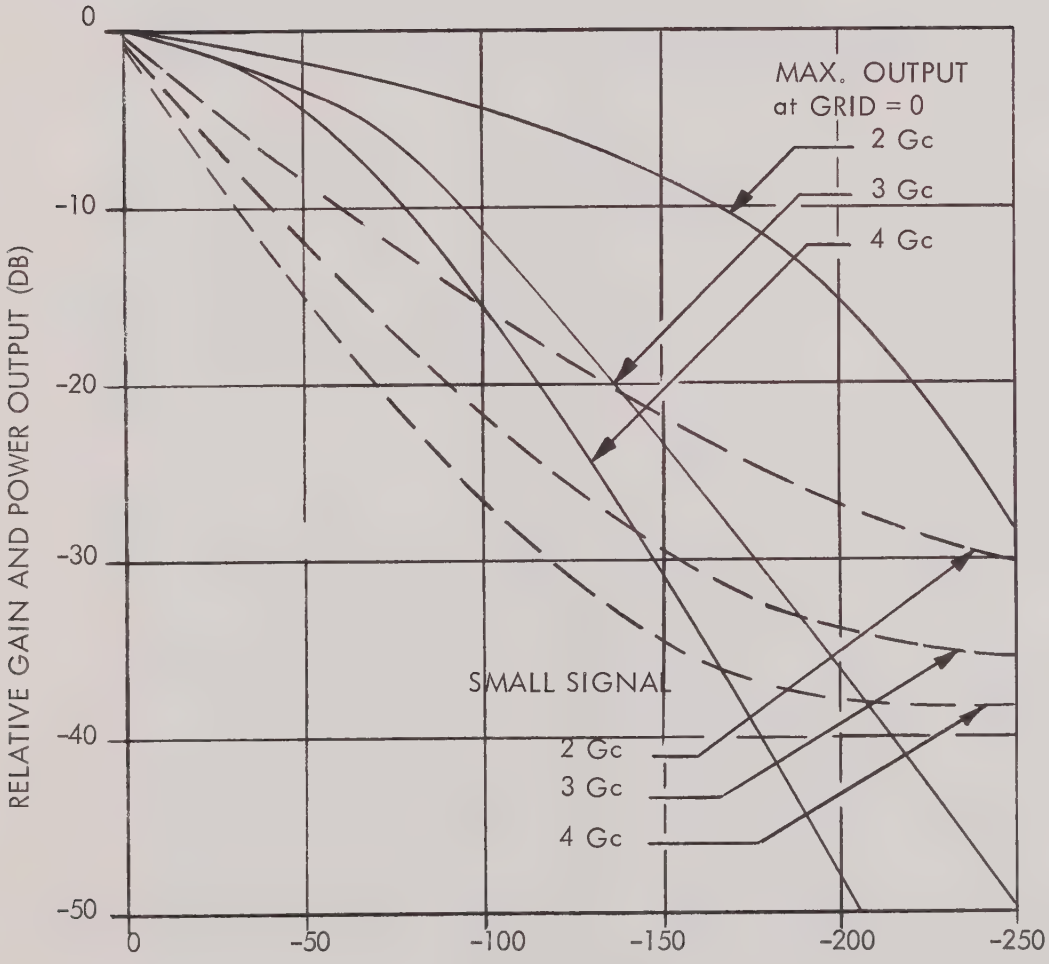


Figure 4

2-4 CIRCUIT DESCRIPTION

In this manual, reference to a panel control is by capital letters and underlined - chassis controls by capital letters only.

Referring to the schematic diagram, input power is applied to selenium rectifier SR3 through POWER switch SW2, SOLENOID fuse F1, and contacts of relay RY3. Direct current from SR3 is filtered by L1, C18, C19, C20 and fed to focusing solenoid L2. A normally closed thermal switch mounted in L2, opens if its temperature exceeds 200° F. RY3 is thereby released and DC power to solenoid is removed. Excessive temperature may damage both TW tube and solenoid and could result from blower failure or abnormal ambient temperature.

Power for transformers T1, T2, T3, T4 and blower B1 passes through POWER switch SW2 and SUPPLY fuse F2. The voltage doubling arrangement of V1, V2 and C2, C3, C4 and C5 produces approximately 1800 volts. This is fed through series regulating tubes V3, V4, V5 connected in parallel and controlled by amplifier tubes V6 and V7 to obtain electronically regulated helix-anode and collector voltage. Reference voltage developed across V9, V10 is compared with supply output voltage at the grids of differential amplifier V7. The amplified difference at the plates of V7 is applied to the cathode and grid of the left half of V6 by using the right half of V6 as a cathode follower. The difference voltage further amplified is then applied to the grids of the series regulator tubes.

Helix voltage is sampled by a resistor divider network consisting of precision resistors R21, R22, R23 and potentiometers R24 and R25. The voltage is changed by varying the ratio of the divider network with panel HELIX control R25. The HELIX CALIB. potentiometer R24 permits adjustment of the resistance ratio to compensate for slight differences in reference tube operating voltages. R24 is factory set, using a 1/2% accuracy meter, connected to the rear HELIX VOLTAGE terminals TP1 and TP2, to give panel HELIX control calibration within 2%.

TW tube helix and anode current is passed through relay RY2 which operates when the current exceeds 5 ma. RY2 contact closure actuates RY1, which in turn removes all high voltage from the TW tube. This protection is required, should the electron beam strike the helix for any reason, such as misalignment or loss of solenoid current. The large beam current would overheat the fine wire of which the helix is formed, severely damaging it and driving out gas which would deteriorate cathode emission. Interlock relay RY1 is de-energized by momentarily turning off POWER switch SW2.

The cathodes of series tubes V3, V4 and V5 furnish high current directly to the TW tube collector. Regulator tube V8 provides an essentially constant drop of 105 volts between the TW tube collector and helix.

TW tube grid bias voltage is obtained from voltage doubling rectifier SR2 supplied by transformer T3, filtered by C6, and C7, and regulated with V11 and V12. Regulated 250 volts is connected across GRID potentiometer R27. Adjustable bias voltage for the TW tube grid is obtained from the arm of R27. V13 prevents positive excur-

sions of the grid and clamps the positive peak of any external modulating signal to TW tube cathode potential.

Transformer T1, rectifier SR1 and filter C1 provides +140 volts for the screen grids of V3, V4 and V5. Indicator lamp I1 is connected across this supply and thus is energized by closure of power switch SW2. RY1 is also operated from this supply.

Meter switch SW1 selects either TW tube helix-anode or cathode current to pass through M1. Two helix-anode current positions are provided, one for normal meter polarity and one for reversed. Secondary emission from the TW tube collector often gives reversed helix-anode current. For simplicity, panel labeling for SW1 indicates HELIX + and HELIX - whereas actually anode current is also included in the meter reading.

SECTION 3 - INSTALLATION AND OPERATION

3-1 INSTALLATION

Upon receipt, carefully unpack and inspect the instrument for damage received from transit Should any damage be found, follow procedure outlined on "Shipment Damage Claim" page at the end of this Manual.

The instrument is designed for either bench or rack operation in normal ambient temperatures. Air flow through the unit and from the solenoid exhaust should be completely unrestricted. Operation in the presence of very strong magnetic fields should be avoided unless external magnetic shielding is provided. Primary power requirements are 105 to 125 volts, 60 cps, approximately 960 voltamperes. If operation at other voltage or frequency is contemplated, consult manufacturer.

The Model 5-6868 is supplied with gray sheet metal sides containing handles. If the instrument is to be rack mounted, the four screws at the corners of each handle side and the screws at each edge of the panel, should be taken out and the sides removed. Insert size 8-32 screws to hold the sheet metal side covers in place. Unit is now ready for inserting into rack. Supports should be provided in the rack to carry the weight of the Model 5-6868 upon its insertion or removal. CAUTION - ambient air near instrument must not exceed 135° F.

3-2 SETTING-UP PROCEDURE

The procedure outlined in this sub-section refers specifically to first-time operation of the unit. However, following a storage period or after repair, the setting-up procedure should be repeated. Should the TW tube be replaced, the new operating information is on the data page supplied with each new tube. Proceed as follows:

1. Before turning on power, disconnect or turn off any grid modulating voltages and set panel controls:

   GRID at -250
   HELIX to voltage value shown on test sheet in rear of manual
   Meter switch to HELIX +

2. Turn on power and allow amplifier to warm up at least 5 minutes.

3. Slowly turn up GRID towards 0, noting that helix-anode current should not exceed 5 ma. Should meter indication be reversed, change meter switch to HELIX - position. Secondary emission from the collector usually gives negative helix-anode current indication. TW tube behavior will determine which meter polarity is required. If current exceeds 5 ma with below GRID setting of 0, the TW tube probably requires mechanical realignment in its solenoid.

   Alignment is accomplished by removing top and bottom perforated dust covers and adjusting the TW tube positioning screws at each end of the solenoid. To permit adjustment, first loosen the lower vertical locking screw at each end of the solenoid. These screws may be reached from the bottom of the instrument. Using adjusting screws which go in at an angle to the steel end ring, orient TW tube to obtain the lowest helix-anode current, all the while advancing GRID control towards 0. ADJUST CAREFULLY TO AVOID HIGH HELIX CURRENT DURING ADJUSTMENT. Should helix-anode current accidentally exceed 5 ma, overcurrent relay will shut off power supply. Operation can be restored by turning POWER switch off and then ON.

   Positioning of the TW tube is most easily accomplished with two screwdrivers, one in each hand. Starting with the tube approximately in the center of the solenoid, slowly wobble the tube with the alignment screws to minimize helix-anode current. Should helix current reverse, change panel meter switch to HELIX position of opposite polarity. Position the adjusting rings on each end of the solenoid using the two front or two rear screws. Once a null is reached, change rear screws or both front screws slightly and then relocate the null with the other pair of screws. Often the new null is lower than the original. If not, move the rings in opposite direction relocating the current null each time. With a little care, helix-anode current usually can be reduced to safe value. Helix-anode current up to about 5 ma is quite safe. However, the lower the current the less chance that gas will be driven from the helix due to high temperature operation. Gas would soon damage the cathode emission and render the TW tube inoperative. Lower current also reduces modulation of the RF output by beam noise and stray magnetic fields. When best null is obtained, tighten locking screws to hold TW tube and rings firmly.

4. When GRID can be set to 0 with helix-anode current at or below 5 ma, change meter switch to CATHODE X20. Current should be equal to operating value of cathode current given on the test data sheet enclosed at the rear of this manual.

5. Apply RF. Input power up to 1 watt will not cause damage. However, only a level less than 50 milliwatts should be used. If RF output can be observed, adjust, if necessary, helix voltage slightly for optimum per-

formance. See also sub-section following titled, SYNCHRONISM. Note setting of HELIX control so it can be returned to correct position if accidentally moved.

6 If possible, pulse or square wave modulated RF input should be applied, and the amplifier output detected and observed on an oscilloscope. If significant 120 cps modulation is noted, very slight repositioning of the TW tube in the solenoid may be required to null out stray magnetic fields from the power transformers in the instrument. Both helix-anode current and AC field nulls occur at essentially the same mechanical positions, so slight turning of the adjusting screws, or rotation of the TW tube a few degrees usually will give best modulation minimum without appreciably affecting helix-anode current. Be sure that locking screws are tightened at the best position and then replace dust covers.

7. Meter switch should be left in CATHODE X20 position during normal operation. An occasional check of helix-anode current is recommended.

8. Turn on or connect to panel GRID connector any grid modulating voltages. Set GRID bias control for best performance. Meter readings will drop in proportion to modulation duty cycle.

SECTION 4 - MAINTENANCE

4-1 GENERAL

CAUTION: Extremely dangerous high voltages exist in this instrument. Observe the utmost care when checking or making repairs

Routine maintenance need consist of the following:

1. Check blower operation every six months or after 1000 hours use, and oil bearings with a few drops of light machine oil in the oil tubes provided. Regular attention to the blower is essential since its failure could result in damage to the TW tube from overheating.

2. Test at regular intervals, the power supply tubes to detect marginal performance. Any voltage regulator tubes removed for test should be returned to their original sockets. INTERCHANGING OR REPLACING VOLTAGE REGULATOR TUBES WILL NECESSITATE RECALIBRATION OF HELIX SUPPLY VOLTAGE

4-2 CALIBRATION OF HELIX SUPPLY VOLTAGE

Calibration of helix supply voltage is accomplished by connecting a voltmeter having 1/2% accuracy or better to the HELIX VOLTAGE test points on the rear of the unit. Unlock the HELIX CALIB. control, located near the right end of the solenoid. Move panel HELIX control over entire range and note readings. Adjust HELIX CALIB.

control so that voltage indications are within 2% for any setting. Lock HELIX CALIB. control.

4-3 TROUBLE SHOOTING

Should a failure occur, follow a logical procedure to locate the cause. Refer, if necessary, to the Theory of Operation section and the schematic diagram included in this manual. Solenoid fuse F1, if blown, should be replaced with 8 amp, 250 volt, type 3AG. Supply fuse F2, should be replaced with 5 amp, 250 volt, type 3AG. Power supply tubes can be observed, to determine if heaters are operating and voltage regulator tubes lit, by removing screws holding top dust cover and sliding it rearward. Operating voltages for the traveling wave tube may be measured as described below. Correct voltages are indicated on the schematic diagram.

Helix-Anode:	Connect a high resistance DC voltmeter to the test points provided on the rear plate of the instrument.
Collector:	Connect the positive lead of a high resistance DC voltmeter to terminal 19 and the negative lead to terminal 18 of TS1, the terminal strip just rear of panel.
Grid:	Connect the negative lead of a high resistance DC voltmeter to terminal 10 of TS1, the positive lead to terminal 11.
Heater:	Connect AC voltmeter to terminals 7 and 8 of TS1.

If tubes have been tested and found to be normal, and supply voltages are incorrect, it is recommended that power be disconnected and faulty components located by a systematic resistance check.

All panel components are accessible by removing the panel screws near the handles. Power supply components are accessible by removing rear plate.

4-4 BLOWER REPLACEMENT

Should blower fail or wear out, remove left gray handle side and cover by loosening screws near panel and captive screws at each corner. Take off plate at rear of instrument and disconnect motor leads. Remove the three screws holding blower assembly to solenoid deck and lift out blower. To change motor or wheel, remove two screws on air intake ring, loosen wheel set screw, and slide wheel off shaft. Behind wheel, nuts holding motor are accessible. After servicing the blower, follow the above procedure in reverse to reassemble the instrument.

4-5 TRAVELING WAVE TUBE REPLACEMENT

To replace the traveling wave tube, take off gray handle sides by removing screws

near corners at edge of panel and below handle, and remove the left sheet metal cover. Disconnect RF and power cables to the tube. Loosen TW tube adjusting screws. Slide tube out hole in left side.

Follow reverse procedure in installing the new tube. Allen head screws in the solenoid adjusting rings may require slight adjustment to expand the rings slightly for a firm but sliding fit around TW tube. Observe due caution to prevent damaging the tube. Follow SETTING-UP PROCEDURE in OPERATION section, except that new value of helix voltage supplied on the replacement tube Data Sheet should be substituted.

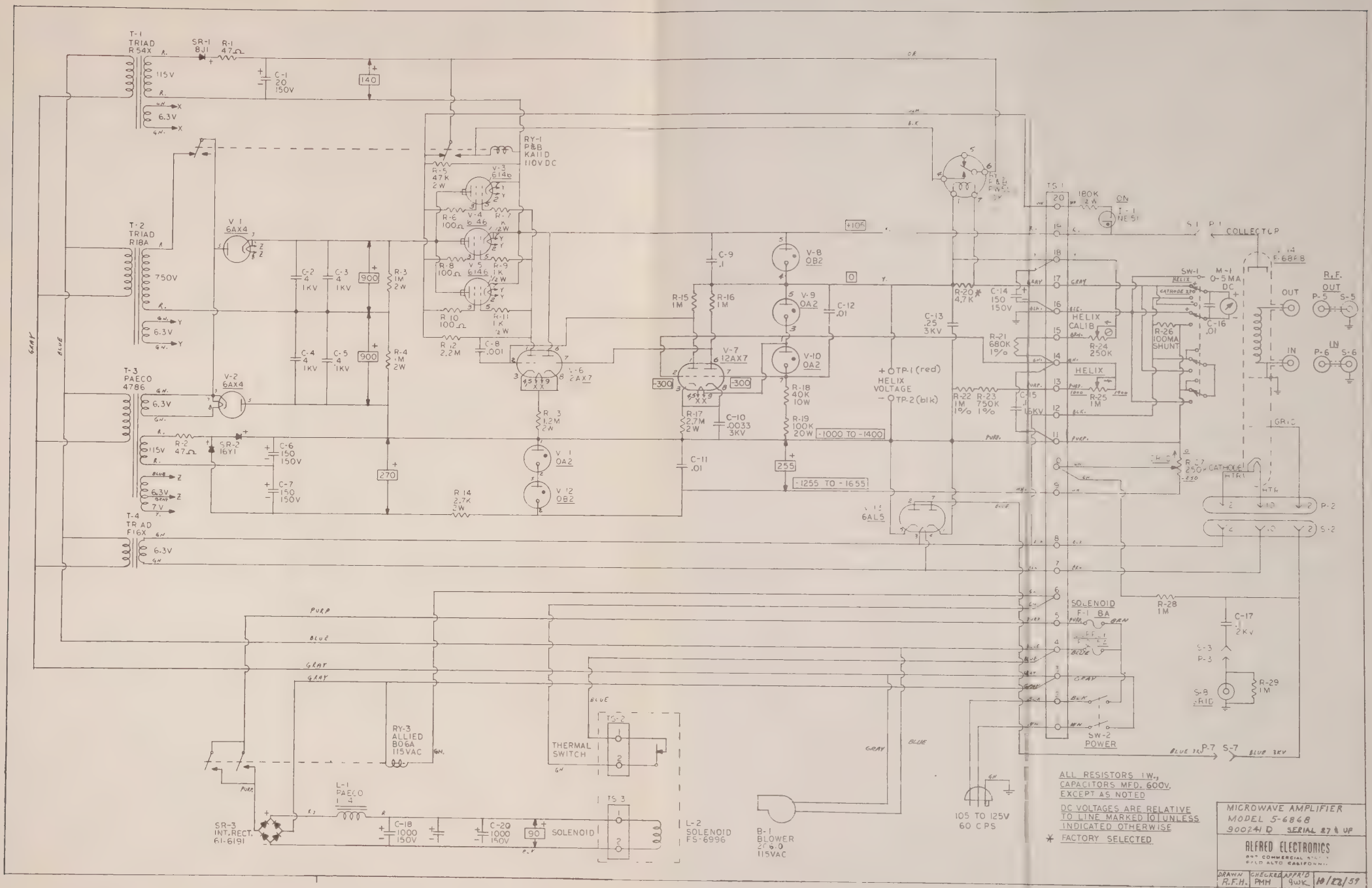
To permit rotation of the TW tube for best alignment, RF leads from the panel may be temporarily disconnected and direct connection made through the hole in the cover side. Avoid excessive air leakage during adjustment. When alignment is complete, install RF leads and replace sheet metal parts. Final orientation of the tube should be such that RF connectors are within $\pm 10^{\circ}$ of horizontal. This is required for maximum air flow across collector radiator fins.

4-6 TRAVELING WAVE TUBE WARRANTY

See Tube Warranty and Replacement Procedure sheet at rear of manual.

4-7 WARRANTY

ALFRED products are warranted against defects in workmanship and materials. This warranty is limited to repair or replacement of products or parts (except tubes, transistors, and batteries) which prove defective within one year after delivery to the original purchaser. ALFRED ELECTRONICS is not liable for consequential damage.


T-1 TRIAD R54X
SR-1 8J1
R-1 47Ω
C-1 20 150V
115V
6.3V
140
RY-1 P&B KA11D 110V DC
T-2 TRIAD R18A
750V
6.3V
V-1 6AX4
C-2 4 1KV
C-3 4 1KV
C-4 4 1KV
C-5 4 1KV
900
R-3 1M 2W
R-4 .M 2W
T-3 PAECO 4786
6.3V
V-2 6AX4
R-2 47Ω
SR-2 16Y1
C-6 150 150V
C-7 150 150V
270
6.3V
7V
T-4 TRAD F16X
6.3V
V-3 6146
V-4 6146
V-5 6146
R-5 47K 2W
R-6 100Ω
R-7 2W
R-8 100Ω
R-9 1K 2W
R-10 100Ω
R-11 1K 2W
R-12 2.2M
C-8 .001
V-6 12AX7
R-13 1.2M 2W
V-12 0B2
R-14 2.7K 2W
V-13 6AL5
+105
0
-300
300
C-9 .1
R-15 1M
R-16 1M
V-7 12AX7
V-8 0B2
V-9 0A2
V-10 0A2
C-12 .01
C-13 .25 3KV
R-17 2.7M 2W
C-10 .0033 3KV
R-18 40K 10W
R-19 100K 20W
-1000 TO -1400
255
-1255 TO -1655
C-11 .01
+ TP-1 (red)
HELIX VOLTAGE
- TP-2 (blk)
R-20 4.7K
C-14 150 150V
R-21 680K 1%
R-22 1M 1%
R-23 750K 1%
C-15 15KV
TS-1
180K 2W
ON
T-1 NE51
S-1 P-1 COLLECTOR
SW-1 HELIX
M-1 0-5MA DC
C-16 .01
R-24 250K
HELIX CALIB
R-25 1M
HELIX
R-26 100MA SHUNT
R.F. OUT
P-5 S-5
P-6 S-6
IN
OUT
GRID
CATHODE
HTR
P-2
S-2
P-7 S-7
BLUE 3KV
SOLENOID F-1 BA
R-28 1M
C-17 .2KV
S-3 P-3
S-8 GRID
R-29 1M
SW-2 POWER
105 TO 125V 60 CPS
RY-3 ALLIED 806A 115VAC
THERMAL SWITCH
TS-2
TS-3
L-1 PAECO 1-4
SR-3 INT. RECT. 61-6191
C-18 1000 150V
C-20 1000 150V
90
SOLENOID
L-2 SOLENOID FS-6996
B-1 BLOWER 266.0 115VAC
PURP
BLUE
GRAY
GRN
BLK
ALL RESISTORS 1W., CAPACITORS MFD. 600V. EXCEPT AS NOTED
DC VOLTAGES ARE RELATIVE TO LINE MARKED 0 UNLESS INDICATED OTHERWISE
* FACTORY SELECTED
MICROWAVE AMPLIFIER
MODEL 5-6868
900241 D SERIAL 27 & UP
ALFRED ELECTRONICS
DRAWN R.F.H. CHECKED PMH APPR'D 9WK 10/22/59

ALFRED

Tube Warranty and Replacement Procedure

Tube Replacement

All TWT and BWO tubes furnished in ALFRED instruments are available from ALFRED ELECTRONICS or the tube manufacturer for either warranty or out-of-warranty replacements. Current prices are given in the Replacement Tube Price List. In general, they are about 10% higher than the manufacturers' list price to allow for ALFRED retest to assure complete specification compliance.

Tube Warranty

On ALFRED supplied TWT and BWO tubes used in catalog instruments, ALFRED ELECTRONICS extends the full warranty given by the tube manufacturer current at time of replacement and, in addition, offers the following minimum warranty:

> "Tubes are warranted to meet specifications against defects in workmanship, materials, and construction for a period of one year or a rated number of heater hours, whichever expires first. If a defect occurs during the warranty period, a prorated adjustment will be made based on the list price of the tube and the percentage of rated heater operating hours or the one year period."

Rated hours are:

Type	Power	Warranty
TWTA	1 to 20 mw	2000 hours
TWTA	100 mw to 1 w	1000 hours
TWTA	2 to 10 w	500 hours
TWTA	(low N.F. 10 to 15 db)	1500 hours
BWO	3 to 10 mw	~~500~~ 1,000 hours

If a tube should fail within the first 50 hours of heater operation and within two months after shipment, the tube will be replaced at no charge.

RETURN AUTHORIZATION

TO OBTAIN WARRANTY CREDIT THE TUBE SERVICE REPORT MUST BE COMPLETED AND RETURNED WITH THE TUBE.

Return Procedure

In case of tube or instrument failure, please contact the factory or your local sales representative for advise or authorization to return either the tube or the instrument to the factory. NO TUBE OR INSTRUMENT WILL BE ACCEPTED FOR REPAIR OR CREDIT ADJUSTMENT WITHOUT WRITTEN AUTHORIZATION AND ACCOMPANYING SERVICE REPORT.

When the authorization is received, pack the tube in a rigid container (use original carton if available) at least 4" larger than the tube in each dimension. Wrap the tube with 1/4" of soft padding material and heavy kraft paper before placing in container. Pack at least 2" of resilient dunnage such as rubberized hair, foam, or similar shock absorbing material completely all around the tube. Mark the container "FRAGILE" and ship PREPAID via air freight, air express or rail express. Do not ship via parcel post or air parcel post since experience has shown that fragile items are more apt to be damaged when shipped via these methods. At least 6" of rubberized hair (or equivalent shock absorbing material) is required for an instrument.

Repairable Tube

If the returned tube is found to be repairable, the user will be asked to issue a purchase order for repair charges determined by the original tube manufacturer. In general, the repair will be at no cost if the tube is in warranty and there is no evidence of misuse or abnormal conditions of operation.

End of Life Replacement

Near the end of tube life, or for other reasons, if tube performance is deteriorating slowly, it may be desirable to continue operating with the defective tube while a replacement tube is being processed. In this case ALFRED ELECTRONICS should be notified as soon as possible of the condition of the tube and a purchase order issued for a replacement tube at list price. Only if the defective tube and service report are received within 3 weeks after date of shipment of the replacement tube, will warranty credit be based on the date defective TWT notification was received at ALFRED ELECTRONICS. The replacement tube is the property of the buyer. However, should the defective tube be repairable, a purchase order should be issued to cover the repair charge.

Warranty Credit

Any applicable credit allowed under the terms of this warranty applies only toward the future purchase of a replacement tube from ALFRED ELECTRONICS. Cash settlements will not be made. In terms of this warranty, a replacement tube must be the same type as that on which credit is allowed. Credit for one tube only may be applied toward the purchase of a single replacement tube. Warranty credit remains in effect for a maximum of 6 months from date ALFRED ELECTRONICS notifies the customer. All credits will be based on the purchase price of the tube which prevails at the time the order for a replacement tube is received by ALFRED ELECTRONICS.

BWO RF Cables

RF OUTPUT CABLE MUST ACCOMPANY BWO TUBES returned for warranty credit, repair, or replacement. If rf output cable is NOT returned, the cable price is added to the normal BWO repair or replacement charge.

Special Conditions

If a returned tube or instrument proves not to be defective after test and evaluation at ALFRED ELECTRONICS, the tube or instrument will be returned at the customer's expense.

The final determination as to whether the tube failed in normal operation thereby bringing it under the applicable warranty or whether the tube was misused thereby excluding it from application of the warranty provisions lies solely with the tube manufacturer.

Data, warranty credit, and prices subject to change without notice.

11/21/62

ALFRED ELECTRONICS

Service Report

Instrument Model _____ Serial No. _____ Date Received _____

TW/BWO Tube Type _____ Serial No. _____ Date Received _____

Date First Tested _____ Date Placed in Service _____ Date of Failure _____

Total Number of Hours of TWT/BWO Heater Operation _____

_____

1. Was operation normal just prior to failure? Yes _____ No _____
2. If not, what was done to adjust it? _____

   _____

   _____
3. Has proper cooling been maintained during tube operation? _____

   _____
4. Did helix overcurrent tripout occur? _____

   _____
5. Was environment normal? (specify) _____

   _____
6. Symptoms - (describe failure) _____

   _____

   _____
7. Operating conditions at time of failure (indicate any unusual conditions) _____

   _____

   _____
8. Name of person to contact regarding evaluation of failure _____

   Telephone No. _____ Signature _____

   Title _____

   Date _____

ALFRED

Tube Warranty and Replacement Procedure

Tube Replacement

All TWT and BWO tubes furnished in ALFRED instruments are available from ALFRED ELECTRONICS or the tube manufacturer for either warranty or out-of-warranty replacements. Current prices are given in the Replacement Tube Price List. In general, they are about 10% higher than the manufacturers' list price to allow for ALFRED retest to assure complete specification compliance.

Tube Warranty

On ALFRED supplied TWT and BWO tubes used in catalog instruments, ALFRED ELECTRONICS extends the full warranty given by the tube manufacturer current at time of replacement and, in addition, offers the following minimum warranty:

> "Tubes are warranted to meet specifications against defects in workmanship, materials, and construction for a period of one year or a rated number of heater hours, whichever expires first. If a defect occurs during the warranty period, a prorated adjustment will be made based on the list price of the tube and the percentage of rated heater operating hours or the one year period."

Rated hours are:

Type	Power	Warranty
TWTA	1 to 20 mw	2000 hours
TWTA	100 mw to 1 w	1000 hours
TWTA	2 to 10 w	500 hours
TWTA	(low N.F. 10 to 15 db)	1500 hours
BWO	3 to 10 mw	~~500~~ 1000 hours

If a tube should fail within the first 50 hours of heater operation and within two months after shipment, the tube will be replaced at no charge.

RETURN AUTHORIZATION

TO OBTAIN WARRANTY CREDIT THE TUBE SERVICE REPORT MUST BE COMPLETED AND RETURNED WITH THE TUBE.

Return Procedure

In case of tube or instrument failure, please contact the factory or your local sales representative for advise or authorization to return either the tube or the instrument to the factory. NO TUBE OR INSTRUMENT WILL BE ACCEPTED FOR REPAIR OR CREDIT ADJUSTMENT WITHOUT WRITTEN AUTHORIZATION AND ACCOMPANYING SERVICE REPORT.

When the authorization is received, pack the tube in a rigid container (use original carton if available) at least 4" larger than the tube in each dimension. Wrap the tube with 1/4" of soft padding material and heavy kraft paper before placing in container. Pack at least 2" of resilient dunnage such as rubberized hair, foam, or similar shock absorbing material completely all around the tube. Mark the container "FRAGILE" and ship PREPAID via air freight, air express or rail express. Do not ship via parcel post or air parcel post since experience has shown that fragile items are more apt to be damaged when shipped via these methods. At least 6" of rubberized hair (or equivalent shock absorbing material) is required for an instrument.

Repairable Tube

If the returned tube is found to be repairable, the user will be asked to issue a purchase order for repair charges determined by the original tube manufacturer. In general, the repair will be at no cost if the tube is in warranty and there is no evidence of misuse or abnormal conditions of operation.

End of Life Replacement

Near the end of tube life, or for other reasons, if tube performance is deteriorating slowly, it may be desirable to continue operating with the defective tube while a replacement tube is being processed. In this case ALFRED ELECTRONICS should be notified as soon as possible of the condition of the tube and a purchase order issued for a replacement tube at list price. Only if the defective tube and service report are received within 3 weeks after date of shipment of the replacement tube, will warranty credit be based on the date defective TWT notification was received at ALFRED ELECTRONICS. The replacement tube is the property of the buyer. However, should the defective tube be repairable, a purchase order should be issued to cover the repair charge.

Warranty Credit

Any applicable credit allowed under the terms of this warranty applies only toward the future purchase of a replacement tube from ALFRED ELECTRONICS. Cash settlements will not be made. In terms of this warranty, a replacement tube must be the same type as that on which credit is allowed. Credit for one tube only may be applied toward the purchase of a single replacement tube. Warranty credit remains in effect for a maximum of 6 months from date ALFRED ELECTRONICS notifies the customer. All credits will be based on the purchase price of the tube which prevails at the time the order for a replacement tube is received by ALFRED ELECTRONICS.

BWO RF Cables

RF OUTPUT CABLE MUST ACCOMPANY BWO TUBES returned for warranty credit, repair, or replacement. If rf output cable is NOT returned, the cable price is added to the normal BWO repair or replacement charge.

Special Conditions

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The final determination as to whether the tube failed in normal operation thereby bringing it under the applicable warranty or whether the tube was misused thereby excluding it from application of the warranty provisions lies solely with the tube manufacturer.

Data, warranty credit, and prices subject to change without notice.

11/21/62

ALFRED ELECTRONICS

Service Report

Instrument Model _____ Serial No. _____ Date Received _____

TW/BWO Tube Type _____ Serial No. _____ Date Received _____

Date First Tested _____ Date Placed in Service _____ Date of Failure _____

Total Number of Hours of TWT/BWO Heater Operation _____

_____

1. Was operation normal just prior to failure? Yes _____ No _____

2. If not, what was done to adjust it? _____

_____

_____

3. Has proper cooling been maintained during tube operation? _____

_____

4. Did helix overcurrent tripout occur? _____

_____

5. Was environment normal? (specify) _____

_____

6. Symptoms - (describe failure) _____

_____

_____

7. Operating conditions at time of failure (indicate any unusual conditions) _____

_____

_____

8. Name of person to contact regarding evaluation of failure _____

Telephone No. _____ Signature _____

Title _____

Date _____

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED products are warranted against defects in workmanship and materials. This warranty is limited to repair or replacement of products or parts (except tubes, transistors, and batteries) which prove defective within one year after delivery to original purchaser. ALFRED ELECTRONICS is not liable for consequential damage.

If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information you will be sent service instructions or shipping data.

2. Upon receipt of shipping instructions forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local Transfer and Storage company may be employed.